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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL SURVEY OF WINDSOR COUNTY,
VERMONT.

BY

J. A. KERR, IN CHARGE, AND GROVE B. JONES.

W. E. McLENDON, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1916.]

COMPLIMENTS

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LETTER OF TRANSMITTAL

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., March 14, 1918.

SIR: In the extension of the soil survey in the State of Vermont work was undertaken in Windsor County and completed during the field season of 1916.

The accompanying report and map cover this survey and are submitted for publication as advance sheets of Field Operations of the Bureau of Soils for 1916, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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MAP.

Soil map, Windsor County sheet, Vermont.

SOIL SURVEY OF WINDSOR COUNTY, VERMONT.

By J. A. KERR, In Charge, and GROVE B. JONES.—Area Inspected by
W. E. McLENDON.

DESCRIPTION OF THE AREA.

Windsor County is situated in the east-central part of Vermont. White River Junction, in the eastern part of the county, is 143 miles from Boston and 258 miles from New York by rail. The county is bounded on the north by Orange County, on the east by New Hampshire, from which it is separated by the Connecticut River, on the south by Windham County, and on the west by Bennington, Rutland, and Addison Counties. It is roughly rectangular in shape, with a length of 45 miles from north to south and a width of 20 miles from east to west, and embraces an area of approximately 948 square miles, or 606,720 acres.

In general the county consists of high ridges running north and south and cut at intervals by the main branches of the Connecticut River. The elevation of the river approximates 350 feet above sea level. Adjacent to the river the general elevation of the hills ranges from 900 to 1,200 feet, increasing quite regularly to the western border, where it ranges from 2,500 to 3,000 feet.

In places the western boundary of the county extends to the Connecticut-Champlain watershed, but the main range of the Green Mountains lies almost wholly beyond the boundary. The topography of much of the western part of the county is nevertheless quite rugged and mountainous, with many slopes of a gradient of 1,000 feet to the mile. The most important ridges are Rochester Mountain, Mount Hunger, Saltash, Ludlow or Okemo Mountain, Terrible Mountain, and Markham Mountain. The highest peak of Ludlow Mountain attains an altitude of 3,372 feet. There is an extensive mountainous section in the east-central part of the county. Here Ascutney Moun-



FIG. 1.—Sketch map showing location of the Windsor County area, Vermont.

tain, an isolated peak of igneous rock, has an elevation of 3,165 feet. Little Ascutney Mountain and Hawks Mountain are very rough and broken.

The surface of the county is broken in detail by a deeply cut and irregular drainage system. The larger streams cut east and south through the main ridges. From north to south these streams are White, Ottauquechee, Black, and Williams Rivers. Their alluvial plains are narrow and irregularly terraced throughout their courses. From the edge of these plains the valley walls rise steeply to heights usually ranging from 400 to 800 feet in their lower courses, increasing to 1,200 to 1,600 feet in the west. The streams have not cut nearly to grade. There is a fall of 400 feet on White River from Stockbridge to its mouth and of 700 feet on the Ottauquechee in its course across the county. Water power is developed on all these streams, there being about 20 water-power plants on Black River. At Cavendish and at Springfield over 100 feet of fall is utilized. There are storage reservoirs on Black River above Tyson. The largest water-power plant in the county is situated on the Connecticut River at Wilder.

There are several deep valleys in the county, which apparently represent the courses of former large streams. On the western boundary the valley of the Ottauquechee River is connected with the headwaters of Black River by a valley cut almost to grade. The route of the Rutland Railroad from the valley of Williams River to that of Black River is through a similar gorgelike valley. On a north and south line through Hammondsville, Greenbush, and North Springfield and near each of these villages there are deep valleys marked by alluvial deposits. The Proctorsville-Gulf road, the road from Gassetts to Springfield, in the same part of the county, the Grafton-Gulf Road, on the southern border, all follow deep cuts. It is probable that yet higher and less well marked valleys were formed in the same way. The depression occupied by the Woodstock Railway from the valley of the White River to that of the Ottauquechee is the best example of this kind.

Settlement of the region which embraces Windsor County was begun in 1754-1760 under town grants from the English Government and under the provincial government of New Hampshire. The military road from Charlestown to Crown Point, crossing the southern part of the county and established during the French and Indian War, made this country more readily accessible. The county was established in much its present form in 1781. The early settlers consisted chiefly of English from the neighboring colonies, and the present rural population is made up largely of the descendants of these early settlers. In late years there has been some

immigration of French from Canada. There are a few very small settlements of Finns, usually in remote sections. There is a considerable foreign population, mostly Polish, in the larger mill towns. Although for many years there have been small cotton mills and woodworking plants throughout the county, the development of manufacturing as an important industry has taken place in comparatively recent years. In 1910, according to the census, the county had a population of 33,681, of which 65.8 per cent was rural. In 1890 the entire population was classed as rural.

The towns are all situated on the larger streams, practically all the mills using water power. Woodstock, with a population of 1,383, situated on the Ottauquechee River, in the central part of the county, is the county seat, and a popular summer and winter resort. Springfield, with a population of 3,250; Windsor, with 1,906; and Ludlow, with 1,621, are the largest towns and the most important manufacturing centers. White River Junction, at the mouth of the White River, is an important railroad center. At Springfield there are large machine and tool works and a shoddy mill. Ludlow and the smaller towns of Smithville, Proctorsville, and Cavendish have large cotton and woolen mills. There are important machine shops at Windsor. A large granite quarry and works and a tannery are located at Bethel, on the White River. There is a large talc quarry and works at Talcville, in the northwestern part of the county, and several talc and soapstone quarries in the south-central part of the county, with works at Chester.

Transportation facilities are very good. The Connecticut Valley route of the Boston & Maine Railroad and the Central Vermont Railway follows the course of the Connecticut River through the county. The Rutland Railroad traverses the southern and west-central parts of the county. The Central Vermont Railway follows the valley of White River, in the northern part, connecting with the Boston & Maine at White River Junction. The Woodstock Railway runs from White River Junction to Woodstock. The White River Railway serves the northwestern part of the county, connecting with the Central Vermont at Bethel. Springfield is reached by a standard gauge trolley line connecting with the Boston & Maine at Charlestown, N. H.

The main public roads are well graded and are surfaced with gravel. All the important roads are good. Practically all parts of the county are supplied with good mail service by stage and rural delivery routes.

CLIMATE.

The climate of Windsor County is marked by long winters, with temperatures generally below the freezing point, and by short, cool

summers. The mean annual temperature is 43.1° F., the winter mean being 18.3° and the summer mean 66° . The highest temperature of which there is a record is 99° F. and the lowest -36° .

The mean annual precipitation amounts to 37.37 inches and the average depth of snow to 93.1 inches. The rainfall is quite uniformly distributed throughout the year, being most abundant in the summer months.

The average dates of the last killing frost in the spring and the first in the fall are May 21 and September 18, respectively, giving an average growing season of 109 days.¹ The date of the latest recorded killing frost in the spring is June 9 and that of the earliest in the fall September 6.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation at Woodstock:

Normal monthly, seasonal, and annual temperature and precipitation at Woodstock.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1880).	Total amount for the wettest year (1857).	Snow, average depth.
December.....	$^{\circ}$ F. 21.5	$^{\circ}$ F. 64	$^{\circ}$ F. -34	Inches. 2.97	Inches. 2.01	Inches. 4.00	Inches. 15.8
January.....	15.7	55	-31	2.81	3.10	2.83	24.0
February.....	17.6	51	-36	2.69	2.71	1.50	24.3
Winter.....	18.3	64	-36	8.47	7.82	8.33	64.1
March.....	30.0	73	-25	3.01	1.67	2.53	19.2
April.....	41.4	83	6	2.75	1.98	3.67	2.3
May.....	54.5	93	17	3.27	2.70	6.46	0
Spring.....	42.0	93	-25	9.03	6.35	12.66	21.5
June.....	64.4	99	32	3.33	1.74	3.45	0
July.....	68.3	99	36	3.93	3.85	4.49	0
August.....	65.3	96	34	3.20	1.47	6.12	0
Summer.....	66.0	99	32	10.46	7.06	14.06	0
September.....	57.7	91	26	3.14	2.64	1.53	0
October.....	45.8	79	14	3.31	3.16	6.32	T.
November.....	34.8	77	-4	2.96	2.67	2.55	7.5
Fall.....	46.1	91	-4	9.41	8.47	10.40	7.5
Year.....	43.1	99	-36	37.37	29.70	45.45	93.1

¹ Woodstock, where these records were taken, is in the Ottawa-Quebec Valley; in the uplands the growing season is probably at least a week or 10 days longer.

AGRICULTURE.

The early settlers of Windsor County engaged in agriculture, producing wheat, corn, oats, and potatoes, and raising cattle and sheep. Cattle and wool were the principal exports. Considerable quantities of maple sirup were manufactured also. Over much the larger part of the county the timber was burned in clearing pastures, but lumbering was carried on to some extent in the winter in connection with farming. Spruce and hemlock timber, hemlock bark for tanning, and later second-growth spruce for pulp have constituted a considerable source of revenue. Following the Civil War the increased opportunities afforded by the cities and by the development of the West drew many of the younger people from the county. Between 1880 and 1890 the production of wool declined rapidly. In some seasons, it is said, no buyers appeared at the local markets. In this decade the population decreased 10 per cent and the number of farms 16 per cent. At the time of this survey (1916) there was, in sparsely settled parts of the county, a considerable number of unoccupied farms on which the buildings were still in good condition. Some of these apparently had been abandoned since 1910. On the other hand, a good many farmers from New York State have settled in the county, finding it more profitable to own land here than to rent high-priced land in New York.

At present dairying is the most important agricultural industry.

Hay and forage, corn, and oats are the principal crops. The 1910 census reports 99,602 acres in tame or cultivated grasses, with a production of 92,693 tons; 3,954 acres in coarse forage (probably almost all ensilage), with a production of 38,669 tons; 2,074 acres of grains cut green (principally oats), with a production of 4,131 tons; and 782 acres in "wild, salt, or prairie grasses," with a production of 536 tons. Most of the hay consists of timothy, redtop, and alsike clover. Usually a mixture of the three is sowed, the first crop being mostly clover and the following crops mostly timothy. Alsike is grown on the uplands and alsike and red clover in the valleys.

Varieties of dent corn are grown for ensilage. Planted close dent corn yields a large bulk of fodder, with a comparatively small quantity of immature grain. Only flint corn regularly matures in this latitude. In 1909 there were 6,659 acres in corn and 3,855 acres in oats, producing, respectively, 290,363 and 130,602 bushels. These crops are fed at home.

Irish potatoes are grown both for home use and for sale at the local markets. They are usually grown in a small way in connection with general farming. In 1909, according to the census 2,415 acres were planted to potatoes, with a production of 367,393 bushels.

There is no one variety that is generally grown, for the industry is not organized.

Most of the farms produce some maple sirup. Usually only trees growing more or less in the open are tapped. The 1910 census reports 312,039 maple trees in the county.

Buckwheat is grown in a small way, principally for home use. There is also a small acreage of barley and of a grain similar to buckwheat locally called "India wheat." Practically no wheat is grown, as it is not needed in the rotation of crops and is not considered profitable.

The 1910 census reported 177,913 apple trees in the county, with a production of 233,234 bushels. There are few young orchards, and little effort is made to grow the fruit on a commercial scale.

In 1909 there were 20,833 dairy cows in the county. There is a good local market for dairy products. Usually the skim milk is used on the farms, most of the cream being sold to outside creameries. There are a few small creameries in the county. Very little milk is shipped to distant markets. A large number of dairy cattle are raised for sale in dairying sections near the large cities. In 1909, 8,313 calves were reported as sold or slaughtered as compared with 19,314 other cattle. The dairy cattle are of a good type, many of them being Jersey and Jersey grades. There are only three or four herds of beef cattle in the county.

At present (1916) comparatively few sheep are raised. Most of the sheep are of the mutton breeds. Sheep sold or slaughtered in 1909 amounted to 16,436.

Hogs are raised almost entirely for home use. The number reported sold or slaughtered in 1909 was 13,822.

The value of live stock and products in 1909 was reported as follows: Animals sold and slaughtered, \$795,781; dairy products, excluding those used at home, \$979,016; poultry and eggs, \$295,994; wool, mohair, and goat hair, \$27,937.

Most of the farmers buy commercial feeds. These feeds are high in protein and are needed to form a balanced ration in dairying, as both the grain and forage crops grown in the county are relatively low in this constituent. The total amount spent for feed in 1909 was \$524,559, or \$172.55 per farm reporting.

The farm buildings are generally substantial and exceptionally well kept. The barns are large enough to give mow space for the hay and grain crops, and are usually connected with the house by a long woodshed. Spring water is often piped to the house and barn. On the average farm the tools do not include a binder or sulky cultivator. Practically all the hay is cut with a machine, but it is loaded and unloaded by hand. Disk harrows are very generally used. Horses weighing from 1,000 to 1,200 pounds are used

for farm work. Occasionally oxen are used both for farm work and lumbering.

The total value of all farm property per farm in 1910 was \$3,790, inventoried as follows: Land 35.1 per cent, buildings 40.4 per cent, implements 7.9 per cent, and domestic animals 15.6 per cent.

The rotation of crops more commonly practiced consists of corn or potatoes one year, oats one year, and grass four years or more. Mowing land is seldom pastured, as there are large fields of woodland or stony land suitable for pasture. After the land is mowed four or five years without the addition of manure there is a considerable falling off in yields and the land is plowed for the tilled crops.

Manure is used in growing corn and potatoes. In addition, commercial fertilizer is applied to potato fields, an acreage application of 200 pounds or more of a 2-10-7¹ mixture being commonly used. Potash is recognized as especially beneficial for this crop. Commercial fertilizer is not commonly used on any other crop. Lime is seldom used on the land. In 1909 the purchase of commercial fertilizer was reported by 61.9 per cent of the farms of the county at a total cost of \$59,299 or \$25.58 per farm. This was double the expenditure in 1890. The use of fertilizer has a marked effect on clover grown on the land the following year.

In 1909 labor was hired on 66.5 per cent of the farms at a total cost of \$536,919, or \$215.63 per farm reporting. A large proportion of this amount was doubtless spent on farms used as summer homes. As a rule labor is hired only through the harvest period. At this time there is a great demand for labor and wages are high. Most of the laborers are competent men and demand good wages.

The number of farms in the county in 1910, according to the census, was 3,745, as compared with 3,796 in 1900 and 3,753 in 1890. The average size of the farms was 143.7 acres in 1910, 140 acres in 1900, and 136 acres in 1890. There are very few large farms in the county. In 1910, 87 per cent of the farms were operated by owners, 10.7 per cent by tenants, and 2.3 per cent by managers. Most of the rented farms are operated by near-by landowners in connection with their own farms. Farm land is usually rented for cash, and, as a rule, where stock is kept and the land is well cared for, the rental is low.

There is a wide range in land values throughout the county. The price of farm land in well-settled localities ranges from \$20 to \$50 an acre, while in thinly settled sections it is as low as \$6 an acre. Forest land is valued at \$6 to \$200 an acre, depending upon the kind of timber and the location. In remote sections second-growth forest land has a higher value than farm land with buildings. The average value of farm land, as estimated by the census, increased

¹ Percentages, respectively, of nitrogen, phosphoric acid, and potash.

from \$6.52 an acre in 1900 to \$9.52 in 1910, which is in part accounted for by the largely increased value of the timber.

SOILS.

The soils of the county are to a large extent of glacial origin. Throughout the uplands the soil-forming material is an unassorted mass of glacial *débris* or till, which was left mantling the different rock formations upon the final retreat of the great ice sheet from the region at the close of the glacial period. The material of the terraces or bench lands which occurs in a narrow but almost continuous belt along the Connecticut River and at intervals along the White and Black Rivers and some of the smaller streams consists of old stratified deposits, while the overflow lands consist of recent alluvium.

The underlying formations are for the most part sedimentary in origin, but highly metamorphosed and greatly folded. The most extensive formation is the schist classified by geologists as the Conway formation. It is highly micaceous, and characterized by thin beds of limestone.¹ These limestone beds are exposed only as narrow outcrops, and their importance as modifying the character of the soils is doubtful. This formation occupies, with little interruption, the eastern, central, and north-central parts of the county. A mountainous belt of massive schists occupies the western tier of towns, and schists and gneisses the towns of Rochester and Weston. In the southern part of the county a formation of gneiss or protogine granite occupies the whole basin of Williams River and extends in diminished width northward to the vicinity of Hammondsville. In the extreme eastern part of the county there is a narrow, broken belt of slaty rock and the eruptive rock of Ascutney Mountain.

The glacial till which mantles the different rock formations through the uplands is comparatively thin. On nearly all of the steep slopes and ridge tops the till is for the most part less than 3 feet deep and rock ledges are of frequent occurrence. Deeper deposits occur at the base of slopes and over some of the gentler ridge tops, where the depth to bedrock ranges from 3 to 10 feet or more. While the till is of mixed origin, it bears a rather close relation to the more important formations over which it lies. Where granite, gneiss, or other massive crystalline rocks occur the surface usually is very rough, the till is shallow or may be entirely absent, and only a very small percentage of the land is suitable for any agricultural use other than for pasture and forestry. The softer schists give a somewhat smoother, although quite hilly country, the average depth of the till is shallow, and a larger proportion is suitable for pasture

¹ See Report of the State Geologist, Vermont, 1911-12.

lands, with many of the gentler slopes suitable for cultivated crops. In general the till consists of a mass of gravel and sand, with a small admixture of silt and clay, and considerable quantities of large rock fragments.

The terrace materials are old alluvial deposits consisting of stratified sand, silt, and gravel. Some of the higher terraces consist almost altogether of fine material and undoubtedly were deposited in quiet water. It is probable that the valleys were irregularly choked by ice dams, resulting in the formation of temporary lakes which were rapidly filled with sediments.

The terrace material is necessarily mixed in origin, but from the character of the gravel carried it must be derived very largely from schists, gneiss, granite, and other crystalline rocks.

Overflow plains occur along nearly all the streams of the county. The best defined areas consist of true alluvium, while those along some of the smaller streams vary from slightly alluvial to colluvial, or may be till or old stratified material that has not been reworked to any extent.

The upland soils are included in the Hollis series, except the very stony areas, which are mapped as Rough stony land. The terraces give rise to two series, the Merrimac series, where the topography is fairly smooth, and the Hinckley series, where the surface is so rough that little of the land is suitable for cultivation. The well-drained alluvial soils are mapped in the Podunk series, and those of a more mixed nature, which remain in a water-logged condition the year round, are mapped as Meadow.

The Hollis series is characterized by brown soils and brownish-yellow subsoils, which are only slightly compact and not heavier than the soils in texture, giving way to grayish stony till at a depth of 24 to 30 inches, or in the stoniest types to bedrock, within less than 3 feet of the surface. The lower subsoil, which contains considerable unweathered material, including a high percentage of mica, has a slight greenish cast. All types of the series have good natural drainage. The Hollis stony fine sandy loam with a heavy phase, the fine sandy loam, and the loam are mapped in Windsor County.

The surface soils of the types included in the Merrimac series are brown to grayish brown and the subsoils are yellowish brown, changing to brownish gray at a depth of $2\frac{1}{2}$ to 3 feet. The soils and subsoils are practically stone free, although varying quantities of waterworn gravel may occur on the surface and throughout the 3-foot section, and stratified beds of sand and gravel form the substratum. The topography is level to undulating and gently rolling and the natural drainage is good to excessive. The gravelly fine sandy loam, loamy fine sand, fine sandy loam, and loam are mapped.

The soils of the Hinckley series differ very little in color and structural characteristics from those of the Merrimac series, but they are characterized by a rough topography and excessive natural drainage. Two types, the gravelly fine sandy loam and very fine sandy loam, represent this series in Windsor County.

The Podunk series includes brown to dark-brown surface soils and lighter brown, sometimes slightly mottled, subsoils. There is more or less finely divided mica in both soil and subsoil, and the lower subsoil frequently contains some gravel. These soils occur as rather high first bottoms, but are subject to overflow. The topography is level to gently undulating. The Podunk series is represented in Windsor County by one type, the fine sandy loam.

Meadow includes strips of poorly drained land along the small streams. The soil is quite variable in texture, and the land too wet for cultivation.

Rough stony land includes areas that are too rough and stony for cultivation.

The following table gives the actual and proportional extent of the several soils mapped in the county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Hollis stony fine sandy loam.	213,312	44.4	Meadow.....	4,416	0.7
Heavy phase.....	56,128		Hinckley gravelly fine sandy loam.....	3,712	0.6
Rough stony land.....	114,624	18.9	Merrimac gravelly fine sandy loam.....	3,328	0.5
Hollis fine sandy loam.....	90,368	14.9	Merrimac loamy fine sand...	1,152	0.2
Hollis loam.....	77,760	12.8	Merrimac loam.....	960	0.2
Merrimac fine sandy loam...	15,040	2.5			
Podunk fine sandy loam.....	14,592	2.4			
Hinckley very fine sandy loam.....	11,328	1.9	Total.....	606,720	

HOLLIS STONY FINE SANDY LOAM.

The Hollis stony fine sandy loam consists of a brown to slightly yellowish brown fine sandy loam, 6 to 8 inches deep, underlain by a brownish-yellow fine sandy loam which changes with depth to a greenish-yellow or grayish fine sandy loam to loamy fine sand, the greenish cast being due to the abundance of mica and fine fragments of rock present. Bedrock commonly occurs at a depth of 2 to 3 feet and occasionally outcrops. Boulders and slabs of schist are scattered over the surface and throughout the soil section. There are comparatively few of these stones larger than a foot in diameter, and few that do not measure at least 3 or 4 inches in one dimension.

The Hollis stony fine sandy loam is the predominant upland type of the county. It is steeply rolling to hilly and mountainous in topography, and is naturally well drained, except in small, scattered areas affected by seepage.

The original forest growth consisted mainly of spruce, pine, hemlock, maple, birch, and basswood (linden). Most of the type has been cut over and the present growth consists largely of maple. In some places, where conditions are favorable, the second growth is largely spruce. Pine occurs in small stands on patches of lighter textured soil, and there is some alder in moist places. There is usually an undergrowth of small maple, which is frequently very dense. Ferns grow luxuriantly in moist places.

A considerable part of the Hollis stony fine sandy loam is cleared of timber and used as pasture land. When properly cared for these pastures produce well, the grasses growing more continuously through the summer than in warmer climates. It is necessary at intervals to cut away the young growth of trees and fern.

Only a very small part of the type is suited to cultivation. On the hills and mountain sides there are many abandoned farms on which the outlines of the cleared fields are hidden in the forest. So far as can be judged, these long-abandoned farms are not capable of being successfully farmed under present conditions, as the steep slopes and irregular rock outcrops would prevent or greatly hinder the use of modern implements and machinery.

The price of uncleared land of this type is based upon the value of the timber growth, and ranges from \$6 to \$200 an acre. Cleared land used for pasture is valued at \$6 to \$20 an acre.

Hollis stony fine sandy loam, heavy phase.—The Hollis stony fine sandy loam, heavy phase, consists of a brown, heavy fine sandy loam to light, mellow loam 8 to 10 inches deep, underlain by a brownish-yellow fine sandy loam. The subsoil usually rests upon bedrock at a depth of 3 feet or less, and in some places grades at a depth of about 30 inches into a grayish, unweathered till which is of a sandy nature and very stony. The surface is thickly strewn with slabs and smaller fragments of micaceous schists, and large quantities of stone occur throughout the soil and subsoil.

This phase is extensively developed throughout the central and northern sections of the county, having about the same distribution as the Hollis loam. In topography, drainage features, and agricultural value it closely resembles the typical Hollis stony fine sandy loam.

HOLLIS FINE SANDY LOAM.

The Hollis fine sandy loam consists of a yellowish-brown, mellow fine sandy loam, 8 to 12 inches deep, underlain by a yellowish-brown

fine sandy loam which grades into a grayish loamy fine sand in the lower part of the 3-foot section. Bedrock or boulders and slabs of schist frequently occur in the subsoil and occasionally in the surface soil. The surface was originally strewn with these rocks, but they have been largely cleared away and used for building fences.

This type occurs throughout the county, being quite extensively developed in the eastern part. It occurs chiefly in belts on the lower part of the valley slopes, occasionally on very gentle upper slopes and rounded ridges. There are no large continuous areas. The topography ranges from gently sloping to quite steeply sloping. The prevailing slope probably approximates 150 to 250 feet in a quarter of a mile. The type is naturally well drained. Owing largely to the covering of grasses and to the snow which lies on the ground throughout the winter there is practically no washing of the surface soil.

Very little of the type is forested, the original growth of spruce, pine, hemlock, maple, and other trees having been removed from most of it. It usually constitutes the better part of the farms on which it occurs, and is devoted to general farming. Probably 80 per cent of the type is used for the production of hay, consisting of timothy, redbud, and clover mixed. Corn and oats are the principal grain crops. Potatoes are grown in a small way for sale. Maple sirup is produced on most of the farms. Apple orchards are common, although fruit is seldom grown on a commercial scale. Dairying and poultry raising are the principal sources of income on all the farms. Some farmers keep small flocks of sheep.

Clover yields ordinarily 1 to 2 tons per acre, timothy 1 to 1½ tons, corn 25 to 60 bushels, oats 30 to 60 bushels, and potatoes 125 to 200 bushels.

The price of land of the Hollis fine sandy loam ranges from \$8 to \$50 an acre, depending upon improvements, topography, and location.

The results of mechanical analyses of samples of the soil and subsoil of the Hollis fine sandy loam are given in the following table:

Mechanical analyses of Hollis fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
120211.....	Soil.....	6.0	7.2	4.4	26.4	21.4	27.3	7.4
120212.....	Subsoil.....	5.8	9.0	5.2	28.6	21.2	24.6	5.7

HOLLIS LOAM.

The surface soil of the Hollis loam is a medium to light textured, brown mellow loam, 8 to 12 inches deep. The subsoil consists of a brownish-yellow, slightly compact loam, changing at a depth of 24 to 30 inches to a yellowish-gray to light brownish gray loam to fine sandy loam, this giving way at about 3 feet to grayish, unweathered till. Bedrock may occur at depths approaching 3 feet, but seldom nearer the surface. Some boulders and slabs of schistose rocks occur on the surface, and schist fragments in varying sizes and quantities occur throughout the soil section, the underlying till usually being quite stony. Most of the rocks large enough to interfere with cultivation have been removed, and the type usually constitutes the improved land of farms on which it occurs.

The Hollis loam is the predominant agricultural soil of a belt comprising roughly the western tier of towns in the county, but not including the towns of Rochester and Weston. It does not occur in large, continuous areas, but at intervals in a predominantly stony country. The topography is rolling to strongly rolling and the natural drainage is generally good, although in small benchlike areas and on slopes there is considerable seepage and the color of the soil and subsoil indicates imperfect drainage and aeration.

The native forest growth of maple, spruce, birch, alder, and other trees has been removed and most of the type is under cultivation. It is used principally for the production of hay crops. Potatoes are grown to some extent, and dairying is an important industry. Yields are similar to those obtained on the Hollis fine sandy loam.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Hollis loam:

Mechanical analyses of Hollis loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
120213.....	Soil.....	3.6	6.4	3.0	17.1	18.6	40.3	10.9
120214.....	Subsoil.....	5.1	6.2	3.4	20.4	19.4	35.4	10.2

MERRIMAC GRAVELLY FINE SANDY LOAM.

The Merrimac gravelly fine sandy loam consists of a light-brown fine sandy loam to loamy fine sand, 6 to 12 inches deep, underlain by a yellowish-brown, fine to medium gravelly sand which rests upon a porous bed of gravel and sand at a depth of 2 to 3 feet. There is a variable content of waterworn gravel, approximately an inch in diameter, in the surface soil, but not enough to interfere seriously with cultivation.

This type is quite inextensive. It occurs in small areas on the terraces along the larger streams, and is the principal terrace soil in the upper part of the Black River Valley. It usually lies at an elevation of 20 to 100 feet or more above the flood plain. Most of the type is cultivated. In crop adaptation and productiveness it is similar to the Merrimac fine sandy loam.

MERRIMAC LOAMY FINE SAND.

The Merrimac loamy fine sand consists of a brown loamy fine sand to fine sand, 6 to 12 inches deep, underlain by a yellowish-brown fine sand to sand, which grades below 2½ feet into a grayish sand or gravelly sand. Usually the soil and upper subsoil are quite free from gravel.

This type is inextensive. The principal areas occur along the Connecticut River, occupying terraces lying at elevations of 100 to 200 feet above the stream level. Other areas occur near Quechee Gulf on the Ottauquechee River. The topography is level to undulating and rolling, with some areas almost rough enough to be classed as the Hinckley gravelly fine sand. All areas are rather excessively drained on account of the light soil and the porous nature of the substratum.

Most of the type is cleared and cultivated, being used for the production of hay, potatoes, and corn. Small to medium yields are obtained. Dairying is of considerable importance and poultry is a source of income on most of the farms.

The price of land of the Merrimac loamy fine sand ranges from \$10 to \$40 an acre, depending upon location, surface features, and position with respect to surrounding soils.

As a grain and grass soil the Merrimac loamy fine sand is not so desirable as the heavier types of the series, or the cultivable upland areas, but the best areas should prove well adapted to the growing of potatoes and a variety of vegetables for the market.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Merrimac loamy fine sand:

Mechanical analyses of Merrimac loamy fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
120203.....	Soil.....	2.6	8.4	5.6	27.4	31.0	19.7	5.3
120204.....	Subsoil.....	4.1	6.4	5.8	37.4	30.0	14.4	1.9

MERRIMAC FINE SANDY LOAM.

The Merrimac fine sandy loam consists of a light-brown, rather light textured fine sandy loam, 8 to 12 inches deep, underlain by a rather loamy fine sand which grades at 12 to 24 inches into fine sand. There is generally a large quantity of coarse gravel in the lower part of the subsoil and in the substratum.

The Merrimac fine sandy loam is the predominant terrace soil of the county. It occurs in detached areas, chiefly at the junctions of streams, but is in the aggregate quite extensive. The largest areas occur along the Connecticut River. The type for the most part lies well above the flood plains, the average elevation being 10 to 20 feet. In some cases, however, the height of flood water could not be determined with accuracy. The villages of Woodstock and Chester are built on areas having very little slope to the stream, and a portion of the low terrace on the Connecticut River at the base of Skitch-awaugh Mountain has been overflowed by the forming of a large ice jam below.

The topography is level to gently sloping. Many areas are marked by one or more abrupt rises of 5 to 20 feet. Both surface drainage and underdrainage are well established, producing a warm, early soil, inclined to be somewhat droughty.

Practically all of this type is devoted to general farming, corn being the principal crop. Timothy and clover do well ordinarily, but in dry seasons they suffer from lack of moisture.

This type is not as productive as the upland soils. Clover yields ordinarily 1 to 2 tons per acre, timothy three-fourths to 1 ton, and corn and oats each 30 to 60 bushels.

The price of land of the Merrimac fine sandy loam ranges from \$20 to \$50 an acre, depending upon location and improvements.

MERRIMAC LOAM.

The Merrimac loam consists of brown, mellow loam to silt loam, 8 to 12 inches deep, underlain by a yellowish-brown loam to silt loam, which passes below a depth of $2\frac{1}{2}$ feet into a grayish loam to sandy loam. The deep subsoil or substratum consists of stratified beds of sand or of sand and gravel.

The area just west of Lewiston is not typical. Here the soil to a depth of 8 to 12 inches is a grayish-brown loam to silt loam, resting upon a brownish-gray to slightly greenish gray loam to silt loam, which may extend to a depth of 3 feet or more or give way to gray laminated clay like that forming the subsoils and substratum of the Orion type in Maine.

This type is confined to a few areas on the high terraces of the Connecticut River from Norwich to a point south of White River

Junction. The topography is nearly level to undulating and gently sloping, and all areas are naturally well drained.

Practically all of the type is cleared and under cultivation. Timothy, clover, oats, and corn are the principal crops, and give good yields. Potatoes do well, but are grown only in a small way.

Land values range from \$15 to \$40 an acre.

HINCKLEY GRAVELLY FINE SANDY LOAM.

The Hinckley gravelly fine sandy loam consists of a brown, light fine sandy loam to loamy sand, 6 to 8 inches deep, resting upon a yellowish fine sand or sand which grades into a grayish sand or gravelly sand at a depth of 2 to 2½ feet. There is considerable gravel in both soil and subsoil, and usually the substratum is quite gravelly and of an open, porous nature.

This type is inextensive, occurring in a number of small scattered areas in the valleys. Some of the most important areas lie along Black River. The topography is very irregular and kamelike to hilly and rough, and the natural drainage is excessive, owing to the porous nature of the material.

In the summer months shallow-rooted plants sometimes suffer from lack of moisture a few days after rains.

Small areas of this type that closely resemble the Merrimac gravelly fine sandy loam are cleared and used in the production of hay and corn, while some of the rougher areas are used for pasture. The remainder of the type is largely in second-growth timber and not used for any purpose.

Land that has been cleared for farming is valued at \$6 to \$20 an acre. The value of the forested areas depends upon the amount and quality of timber they support.

Potatoes and some of the berries could be successfully grown on any of the areas of this type that are smooth enough to farm. The rougher areas can best be used for forestry.

HINCKLEY VERY FINE SANDY LOAM.

The Hinckley very fine sandy loam consists of a brown, mellow very fine sandy loam, 8 to 10 inches deep, underlain by a brownish-yellow very fine sandy loam, which changes at a depth of 24 to 30 inches to a gray fine sand to very fine sand. The underlying unweathered material consists of stratified beds of very fine sand and fine sand, with occasional layers of gravel in places.

In numerous small spots the soil material consists of a very fine sand, and in some areas it is a loamy fine sand to very fine sand. The areas along and to the east of the Ompompanoosuc River in the northeastern corner of the county consist mostly of Hinckley

fine sand and very fine sand. Here the surface soil to a depth of 6 or 8 inches is a light-brownish, slightly loamy fine sand to very fine sand, and the subsoil is a yellowish fine sand resting at a depth of 24 to 30 inches upon beds of grayish sand.

This type is most extensively developed on the Connecticut River, midway along its course in the county. Other areas occur along the White and Ottauquechee Rivers. The type has a maximum elevation of 250 feet above the level of the stream, and frequently extends a mile from the river. The slopes are irregular both in degree and in uniformity. Occasionally there are bluffs and deep erosions at the foot of the slopes in which patches of bedrock are exposed. Over most of the type, however, there are no rock exposures, although the streams have cut rather deep channels. Generally the topography is quite irregular, ranging from strongly undulating to decidedly hummocky and kamelike. In the vicinity of Windsor there are several distinct narrow terraces separated by steep bluffs.

The areas between North Hartland and White River Junction and the light sandy areas in the northeastern corner of the county are not farmed except in small patches where the surface features are most favorable, although a considerable acreage is cleared and used as pasture land. A large proportion of the areas farther south along the Connecticut River are cleared and used as pasture land and in the production of hay crops, corn, and oats. Potatoes are grown in a small way and give fair to good yields. Dairy products and poultry are sources of income on the majority of the farms.

Forestry and pasture are the best uses to which the roughest areas of the type can be put.

PODUNK FINE SANDY LOAM.

The Podunk fine sandy loam consists of a brown to dark-brown fine sandy loam to very fine sandy loam, 8 to 12 inches deep, underlain by a yellowish-brown loamy fine sand to fine sand. More or less finely divided mica occurs in both soil and subsoil. There is frequently some gravel in the lower subsoil, but the surface soil is free from gravel.

This type is developed in rather widely separated areas along all the large streams of the county, but not much of the type lies along the Connecticut River or along White River below the forks.

The topography as a whole is level to gently sloping. In places there are slight elevations, making the surface somewhat irregular. Both surface drainage and underdrainage are well established. Occasionally the type is overflowed in the spring, owing to the melting of the snow, but this does not greatly delay plowing.

Practically all of the Podunk fine sandy loam is under cultivation. It is used principally in the production of hay, although nearly all of the other crops of the region are grown in a small way. Good to excellent yields are usually obtained.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Podunk fine sandy loam:

Mechanical analyses of Podunk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
120215.....	Soil.....	0.8	2.6	2.9	30.2	28.4	28.1	6.9
120216.....	Subsoil.....	5.2	7.8	4.7	30.4	22.4	24.6	5.2

ROUGH STONY LAND.

Rough stony land comprises areas that are too rough and stony to be classed as a stony fine sandy loam. In places, especially on the shoulders and tops of ridges, it consists almost entirely of rock outcrop. Over the larger areas there is often a thin covering of soil, with occasional patches of deep soil, the latter usually occurring at the heads of water courses.

Rough stony land occurs on ridge areas and river bluffs throughout the county, being most extensively developed in the southeastern part, in the towns of Windsor, West Windsor, Reading, and Baltimore.

There is usually a good growth of trees over areas of Rough stony land. Many areas convenient to farm lands are pastured.

MEADOW.

Meadow comprises small areas of poorly drained land. It occurs in narrow strips along the small streams, in depressions where no well-defined streams have developed, and in a few places where seepage collects. The soil is quite variable in texture, but in general may be described as a dark-gray to black fine sandy loam to loam, underlain at a depth of 8 to 12 inches by a grayish fine sandy loam to sandy loam. In spots a true muck soil is developed, but the depth of the muck layer usually is shallow. All areas classed as Meadow are too wet in their present condition to be used for cultivated crops. Most areas are subject to frequent overflows and remain in a waterlogged condition the year round. It is probable that the original growth consisted largely of birch and soft maples, but this has been removed, the characteristic growth now consisting of alder, aspen, and coarse water-loving grasses and rushes. Some areas are kept

clear of tree growth and the grasses are cut for hay. The pasturage afforded during the summer months is the chief use of the Meadow areas.

Little or no attention has been given to the drainage of the wet bottom lands, but with proper drainage established they should prove especially desirable for the production of hay and ensilage corn. The more favorably located areas could be used to advantage in growing cabbage, onions, and celery. Most areas are susceptible of being drained at a very reasonable cost.

SUMMARY.

Windsor County is situated in the east-central part of Vermont, on the Connecticut River. It embraces an area of approximately 948 square miles, or 606,720 acres. The topography is hilly to mountainous, the elevation ranging from 350 feet on the Connecticut River to about 3,000 feet on the western border.

In 1910, according to the census, the county had a population of 33,681, of which 65.8 per cent was rural. Woodstock, with a population of 1,383, situated in the central part of the county, is the county seat and a popular summer and winter resort. There are numerous small manufacturing towns on the larger streams.

The county has good railroad facilities, and the main public roads are well surfaced and graded.

The climate is marked by long, cold winters and cool summers with only short periods of hot weather. The mean annual temperature is 43.1° F., and the average yearly precipitation amounts to 37.37 inches, the rainfall being quite uniformly distributed throughout the year.

At present dairying is the most important agricultural industry. Hogs are raised for home use. Hay and forage, corn and oats, are the principal crops. Irish potatoes, buckwheat, and barley are grown to some extent. There are small apple orchards throughout the county, but no attempt is made to grow the fruit on a commercial scale. Most of the farmers make some maple sirup.

The soils of the county are to a large extent of glacial origin. The upland soils are included in the Hollis series, the terrace soils in the Merrimac and Hinckley series, and the bottom land soils in the Podunk series. Areas that are too rough and stony for cultivation are mapped as Rough stony land, and small areas of wet land, in which the soil material is quite variable in texture, as Meadow.

The Hollis stony fine sandy loam is the predominant upland type of the county, its heavy phase being extensively developed throughout the central and northern parts. A considerable part of these soils is cleared and used as pasture land. Only a small part is cul-

tivated. The Hollis fine sandy loam occurs throughout the county, being extensively developed in the eastern part. About 80 per cent of this type is used for the production of hay. The Hollis loam is the most important soil type in the extreme western part of the county. It also is used principally for the production of hay.

The Merrimac gravelly fine sandy loam, fine sandy loam, and loam are used mainly for the production of timothy, clover, oats and corn. The gravelly fine sandy loam and loam are inextensive, while the fine sandy loam is the predominant terrace soil of the county. The Merrimac loamy fine sand is inextensive, and is used mainly for the production of hay, potatoes, and corn.

The soils of the Hinckley series differ very little in color and structural characteristics from those of the Merrimac series, but they have a rough topography and are excessively drained. The Hinckley gravelly fine sandy loam is inextensive. Most of it is in second-growth timber. Some small areas are used for the production of hay and corn, and some of the rougher areas are used for pasture. The Hinckley very fine sandy loam is most extensively developed in the eastern part of the county along the Connecticut River. A large part of the type is cleared and used as pasture land and for the production of hay, corn, and oats.

The Podunk fine sandy loam occurs along all the large streams of the county. Practically all of it is under cultivation, hay being the principal crop.



[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

"That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture."

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Vermont.